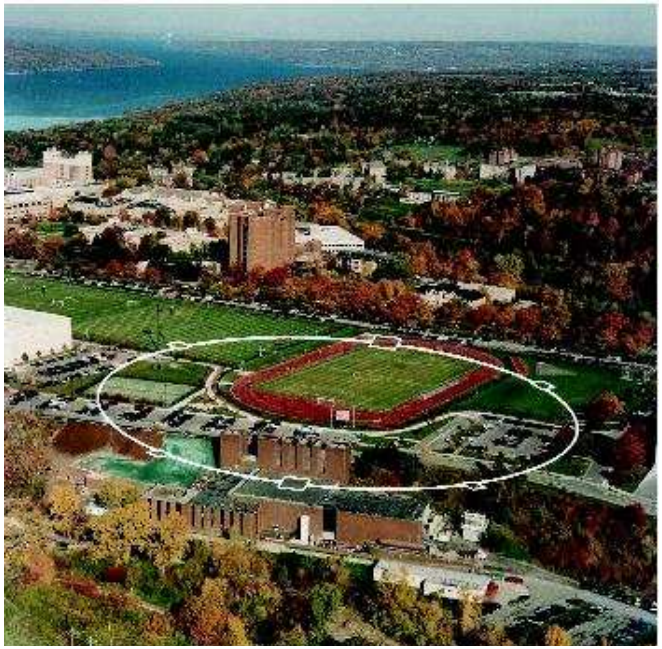
Cornell University
Laboratory for Elementary-Particle Physics

CesrTA Status Report

Mark Palmer

for the CesrTA Collaboration

March 4, 2009



Outline

- Recent Updates
  - January run/February Down Overview
  - Optics & LET
  - xBSM
  - Electron Cloud Studies
    - Tune Data-Simulation Comparisons
    - RFA Data
- Status and Plans

Will cover a few things – expect that some topics will be covered in talks from other labs…

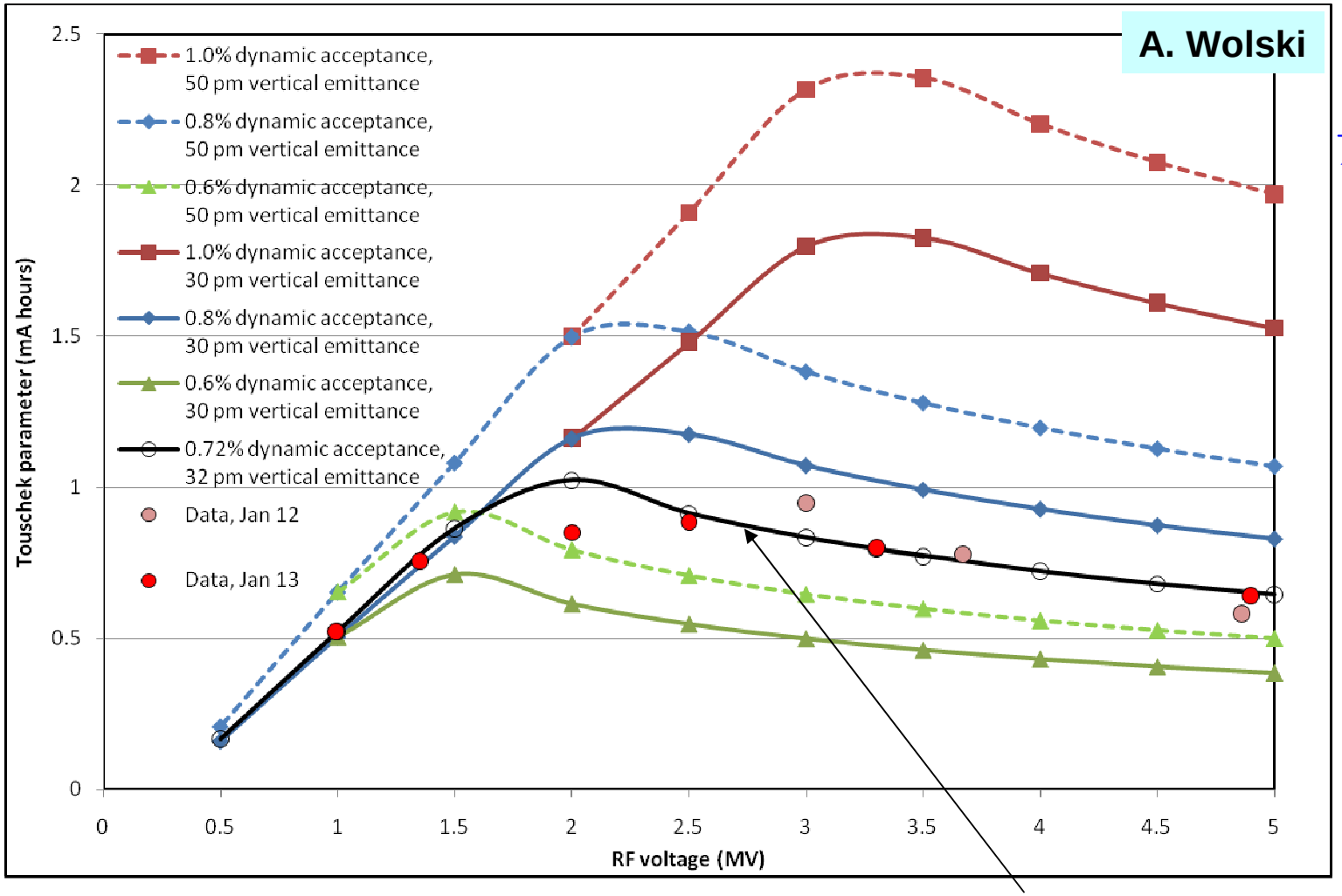
CesrTA Run & Down Recap

- Completed experimental run 2/2/2009
  - Low emittance correction in 2.085 GeV baseline optics
  - X-ray Beam Size Monitor (xBSM) commissioning
  - EC Measurements
    - RFA & TE wave measurements
    - Dynamics
  - General instrumentation/feedback tests/commissioning
- 13 visitors
  - LET - J. Jones, A. Wolski
  - xBSM – J. Flanagan, H. Sakai
  - EC – S. De Santis, R. Holtzapple, K. Shibata, L. Wang
  - Feedback – D. Teytelman, M. Tobiyama
  - CLIC – H. Schmickler
  - Instrumentation – A. DellaPenna, I. Pinayev
- 2nd upgrade down is just concluding (first beam in CESR stored early this morning)
  - ☑ Installation of PEP-II experimental hardware
  - ☑ Installation of photon stop chamber for 5GeV operation of the CesrTA L0 wiggler straight
  - ☑ *Planned Contingency item:* Replacement of SRF cavity that failed during summer 2008
  - ☑ Installation of xBSM beam line front end for electron beam
  - ☑ Continue with instrumentation upgrade for 4ns bunch train operation
  - ☑ *New Contingency item: Repair of 15BW dipole coils (overheating bus-bar connection)*

Optics and LET-January Run

- Low emittance 2.085 GeV optics loaded and corrected
  - Correction methods tested
  - Beam-based alignment measurements
  - Coupling and dispersion bumps created for tuning
- Emittance measurements begun…
  - Touschek lifetime measurements initially used to characterize beam size
  - xBSM measurements as detector and optics were characterized
- Ongoing program of magnet alignment to improve emittance
  - Alignment work continued throughout the run
  - 2 anomalous locations in the ring have been identified which are being scrutinized.

First Detailed Optics Correction ⇨ Touschek Study ⇨ xBSM Measurement (Preliminary)



$$\frac{1}{\tau} = \frac{1}{d} + \frac{i_{bunch}}{b}$$

Touschek Parameter

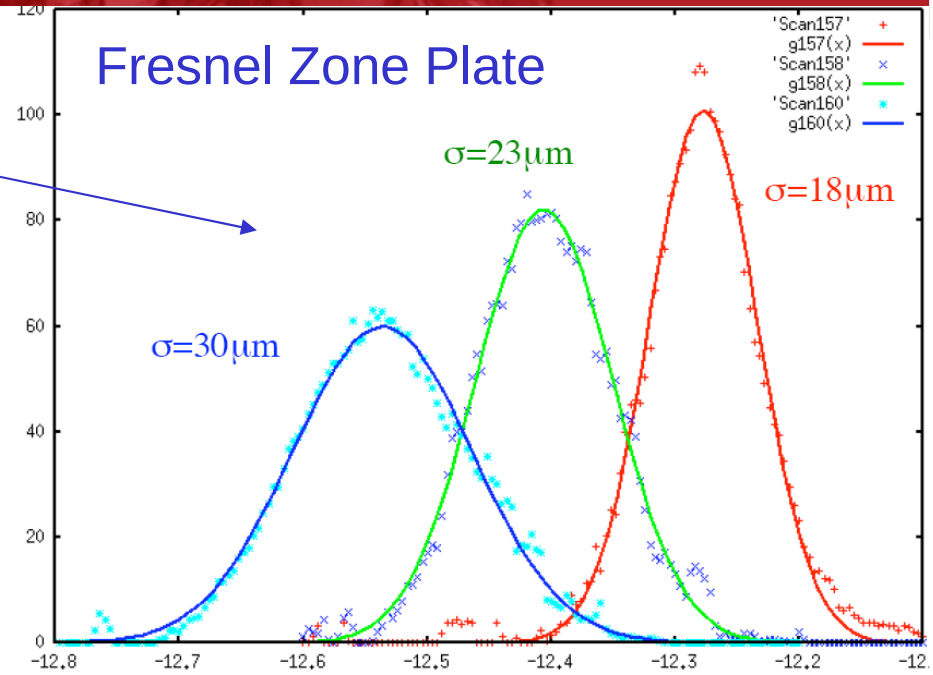
Measured energy acceptance ~ 0.7% → ε_v ~ 32pm

From xBSM σ_v ~ 15±5 μm → ε_v ~ 38pm

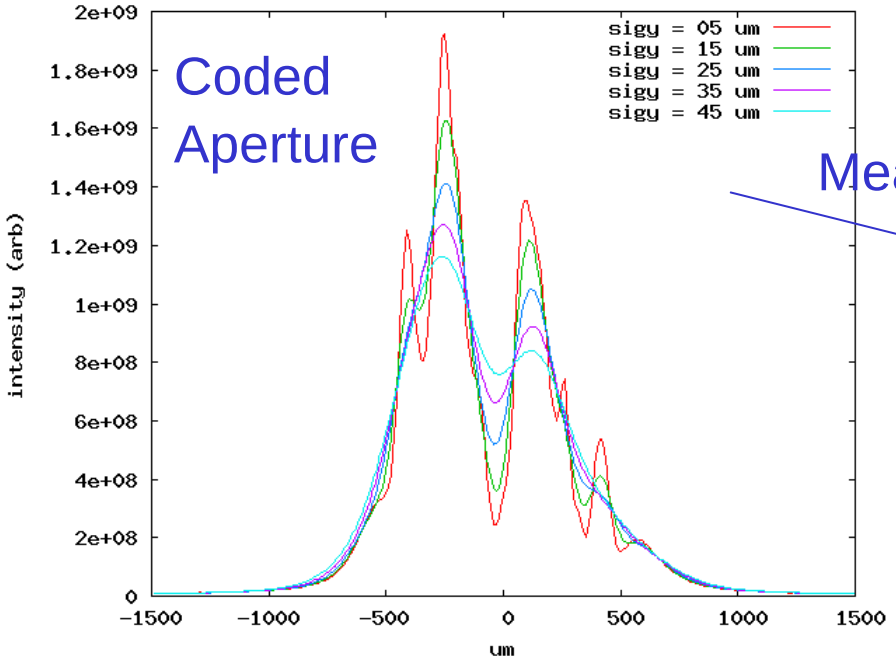
Appear to be within a factor of ~2 of the 20pm target

xBSM Snapshots (Preliminary)

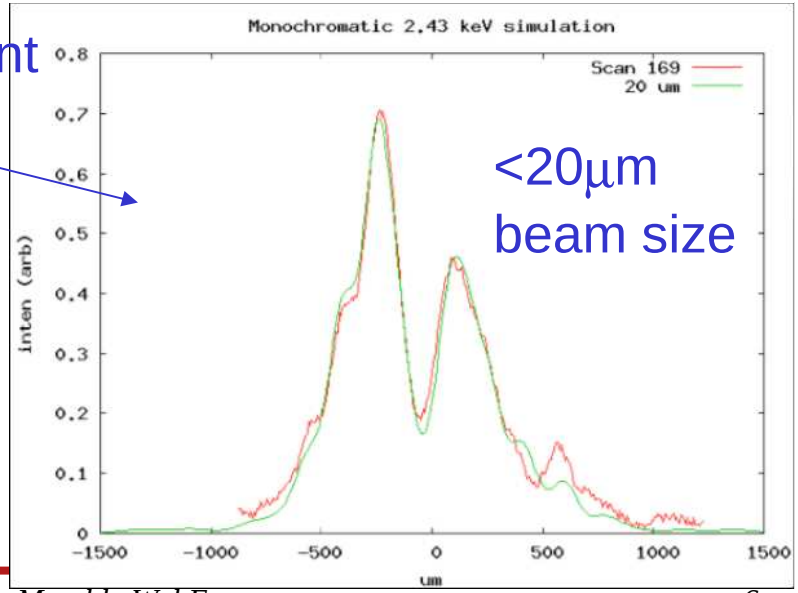
- Scan of coupling knob
- Coded aperture measurements
- Smallest recorded size:
  ~15 μm (but further calibration work needed)



Simulations



Measurement

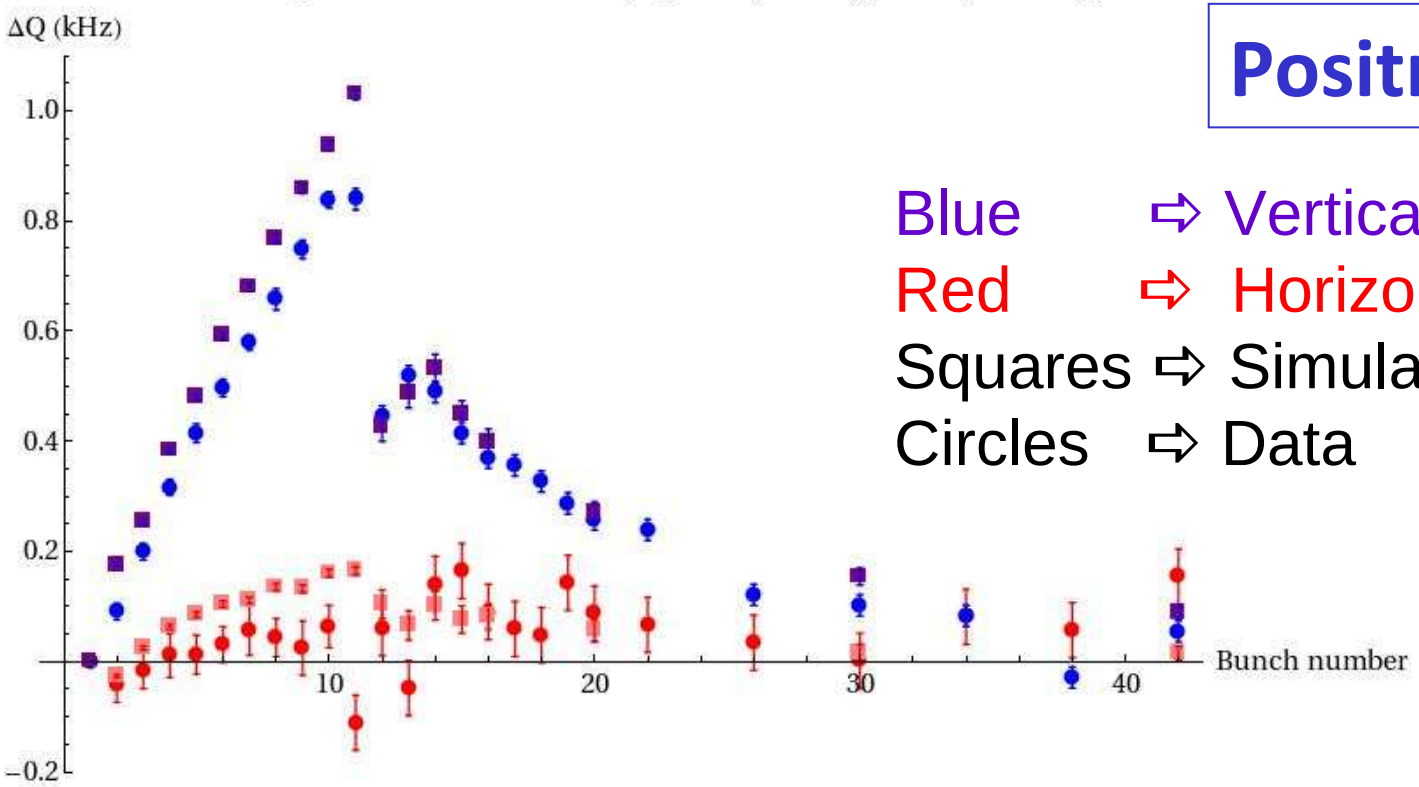


EC Data-Simulation Updates

- Simulations of tune shifts in POSINST at Cornell and LBNL, using a new option in POSINST for offseting the bunches, have shown that the tune shifts of a single bunch are different if the whole train is oscillating coherently, than if just the single bunch is oscillating.
  - Horizontal tune shifts in a dipole are much smaller when the whole train is oscillating coherently. This is particularly relevant for the tune shift measurements at CesrTA, since we kick the whole train coherently to do the measurement.
  - Tune shifts calculated for a coherently oscillating beam give better agreement with measurements: see following three slides.
- January run
  - Studies of systematic effects in the tune shift measurements were carried out.
  - Measurements of tune shift vs. current for long trains (10, 20, 45 and 116 and 145 bunches) were carried out (evidence of instability developing at the end of the 116 and 145 bunch trains)
  - RFA and TE wave measurements to characterize EC density in drifts, dipoles and wigglers
  - Work on comparisons between RFA and TE wave measurements as well as systematics checks for both

10 Bunch Train with Trailing Witness Bunch(es) Data-POSINST Comparison (Preliminary)

Coherent tune shift vs. bunch number
Tune shift data 1.885 GeV 10 bunch train 0.75 mA/bunch positrons 4/2/07
Purple Squares: Simulation, vertical tune shift
Blue Circles: data, vertical tune shift
Pink Squares: Simulation, horizontal tune shift
Red circles: data, horizontal tune shift
Simulation,
CESR–TA drift at 1.885 GeV: SEY=2.0, epk=310,r=15%, QE=12%,51 nicks,pa=1
CESR–TA dipole at 1.885 GeV: SEY=2.0, Epk=310, r=15%,QE=12%, 51 nicks, p



Experimental Procedure:
- 10 bunch leading train which generates the cloud
- Witness bunches placed at various delays behind the initial train
- Measure tunes of all bunches simultaneously

Positron Beam

Blue ⇨ Vertical ΔQ
Red ⇨ Horizontal ΔQ
Squares ⇨ Simulation
Circles ⇨ Data

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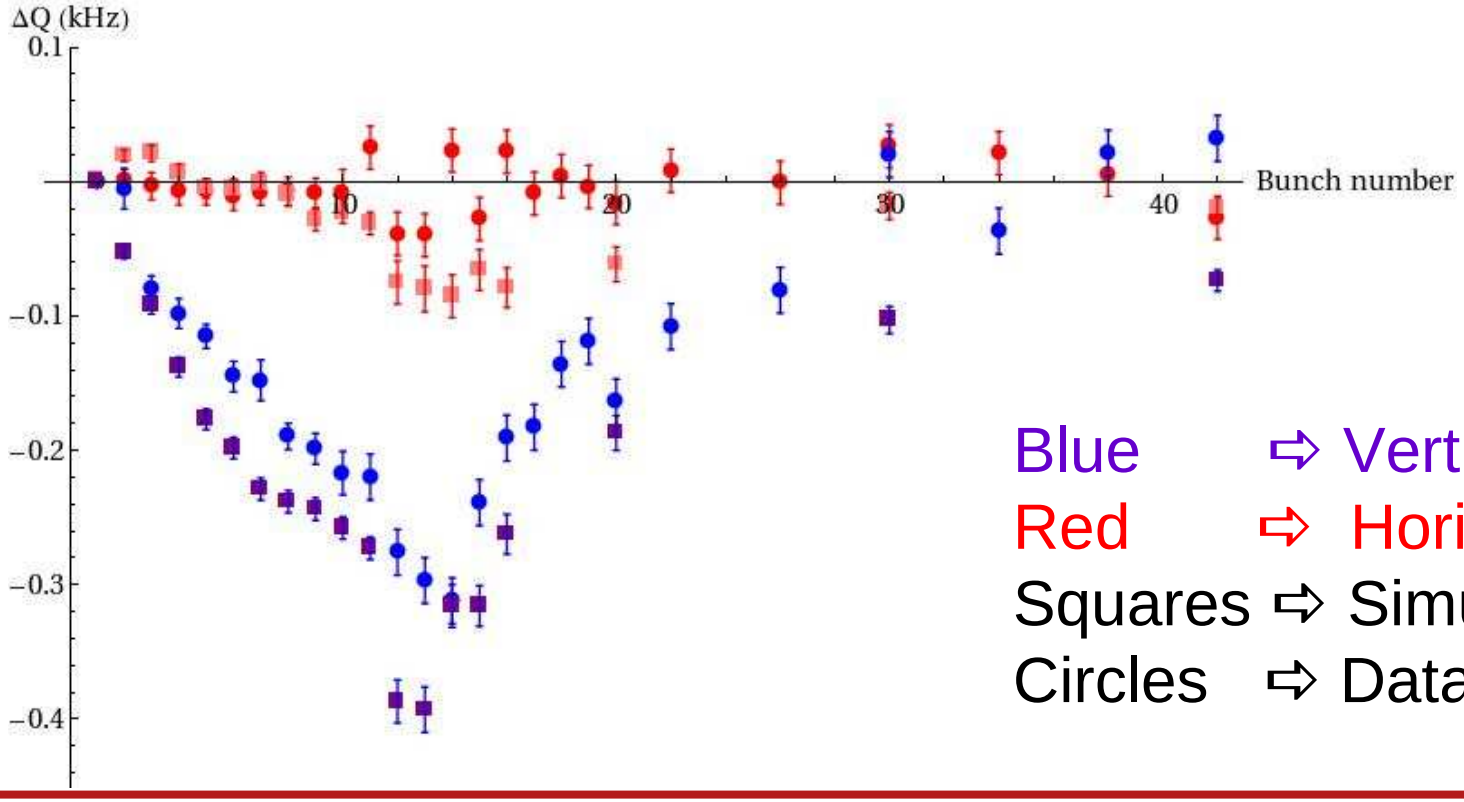
Simulation,
CESR–TA drift at 1.885 GeV: elec, SEY=2.0, epk=310,r=15%, QE=12%,51 nick
CESR–TA dipole at 1.885 GeV: elec, SEY=2.0, Epk=310, r=15%,QE=12%, 51 ni

Electron Beam

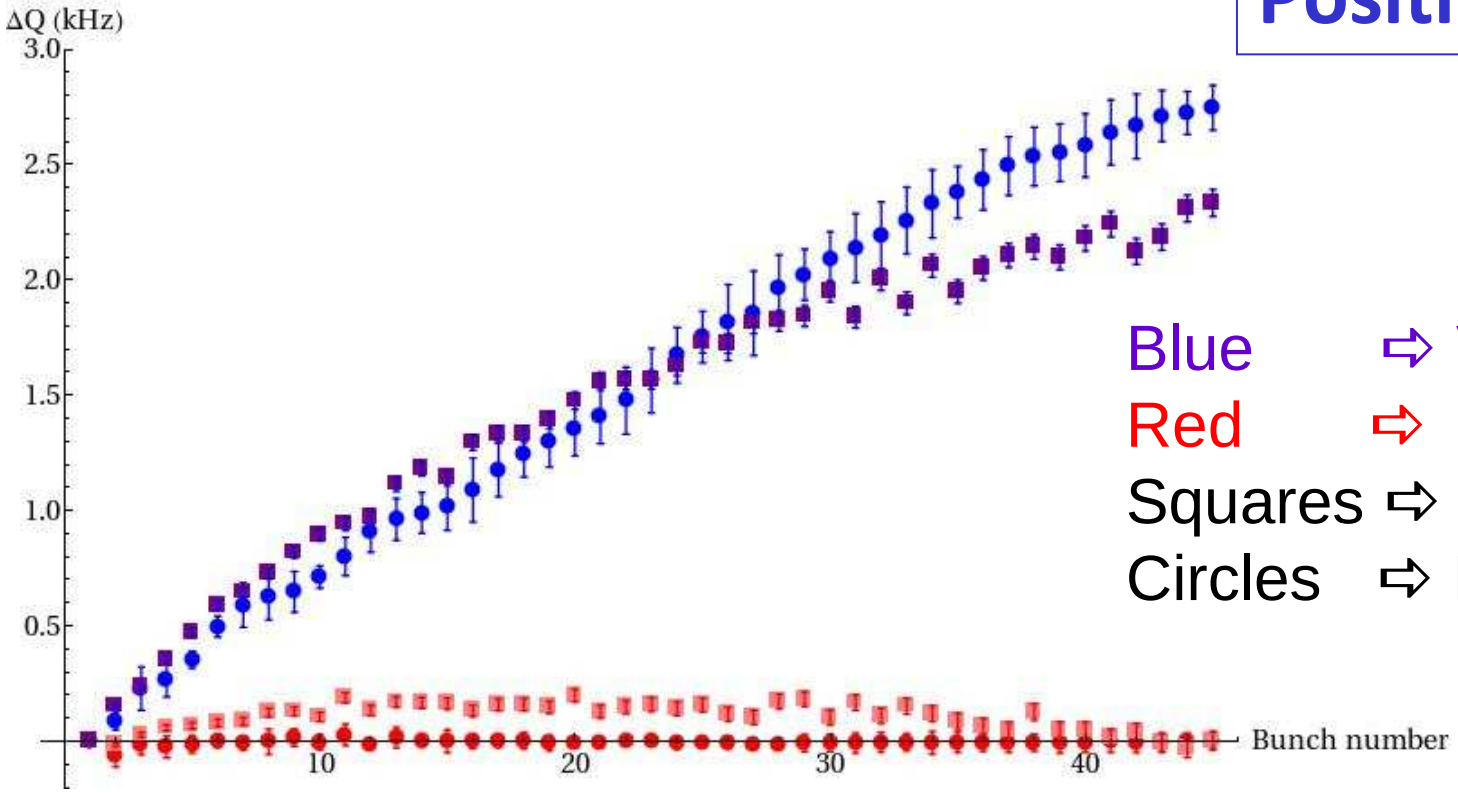


Blue ⇨ Vertical ΔQ
Red ⇨ Horizontal ΔQ
Squares ⇨ Simulation
Circles ⇨ Data

45 Bunch Train: Data-POSINST Comparison (Preliminary)

Coherent tune shift vs. bunch number
Tune shift data 2.085 GeV 45 bunch train 0.75 mA/bunch positrons 1/26/09
Purple Squares: Simulation, vertical tune shift
Blue Circles: data, vertical tune shift
Pink Squares: Simulation, horizontal tune shift
Red circles: data, horizontal tune shift
Simulation,
CESR–TA drift at 1.885 GeV: SEY=2.0, epk=310,r=15%, QE=12%,51 nicks,pa=1
CESR–TA dipole at 1.885 GeV: SEY=2.0, Epk=310, r=15%,QE=12%, 51 nicks, p

Positron Beam



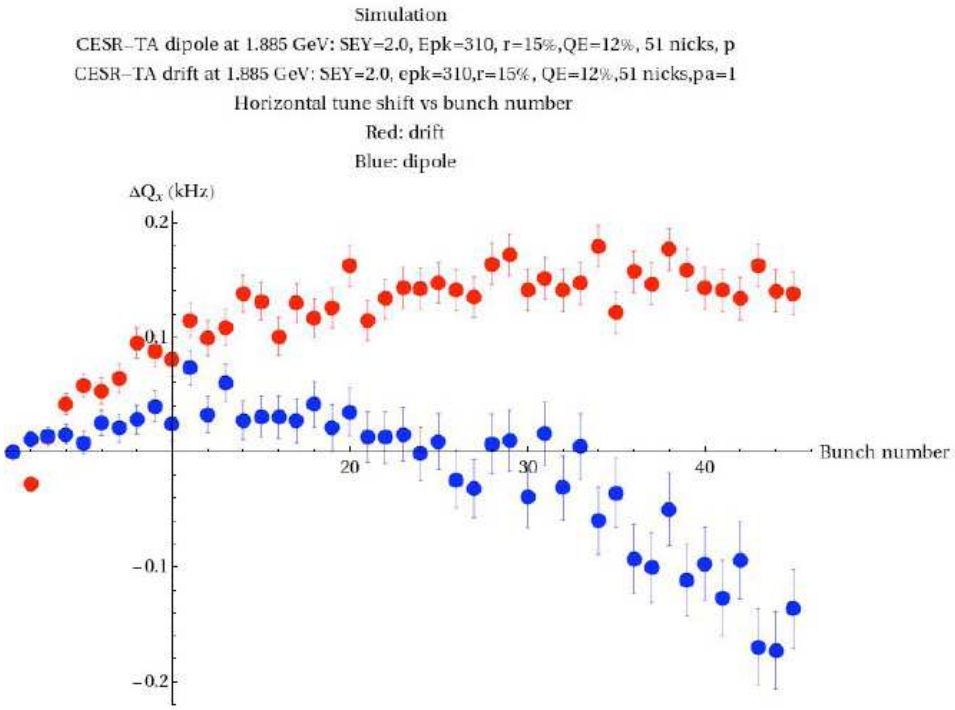
Blue ⇨ Vertical ΔQ
Red ⇨ Horizontal ΔQ
Squares ⇨ Simulation
Circles ⇨ Data

Drift vs Dipole Contributions

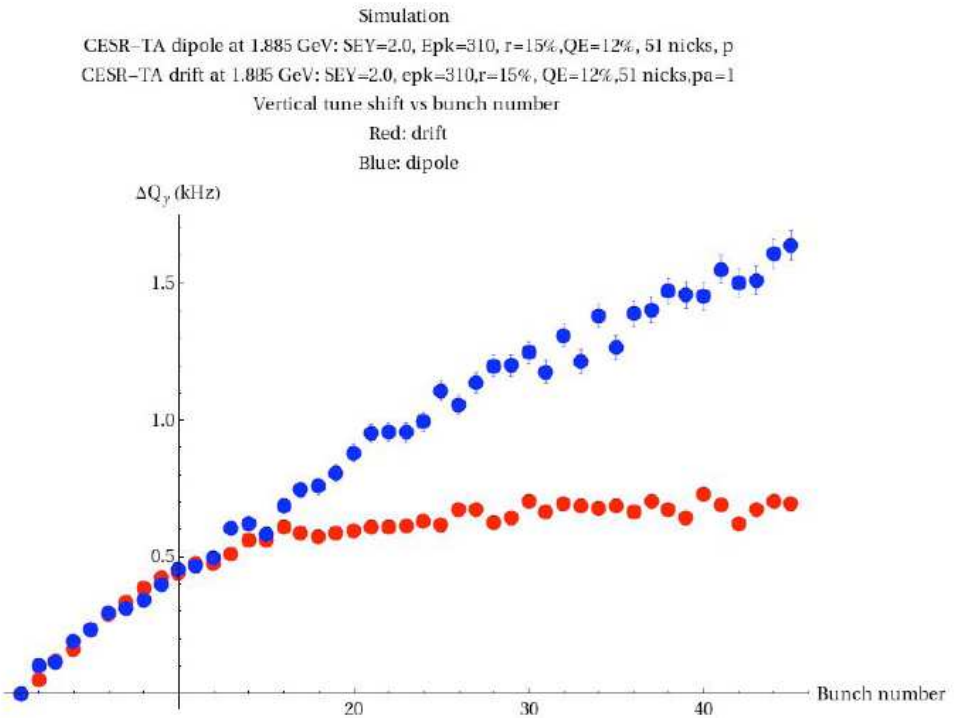
- Comparison of drift (red) and dipole (blue) contributions to tune shifts in each dimension

Positrons

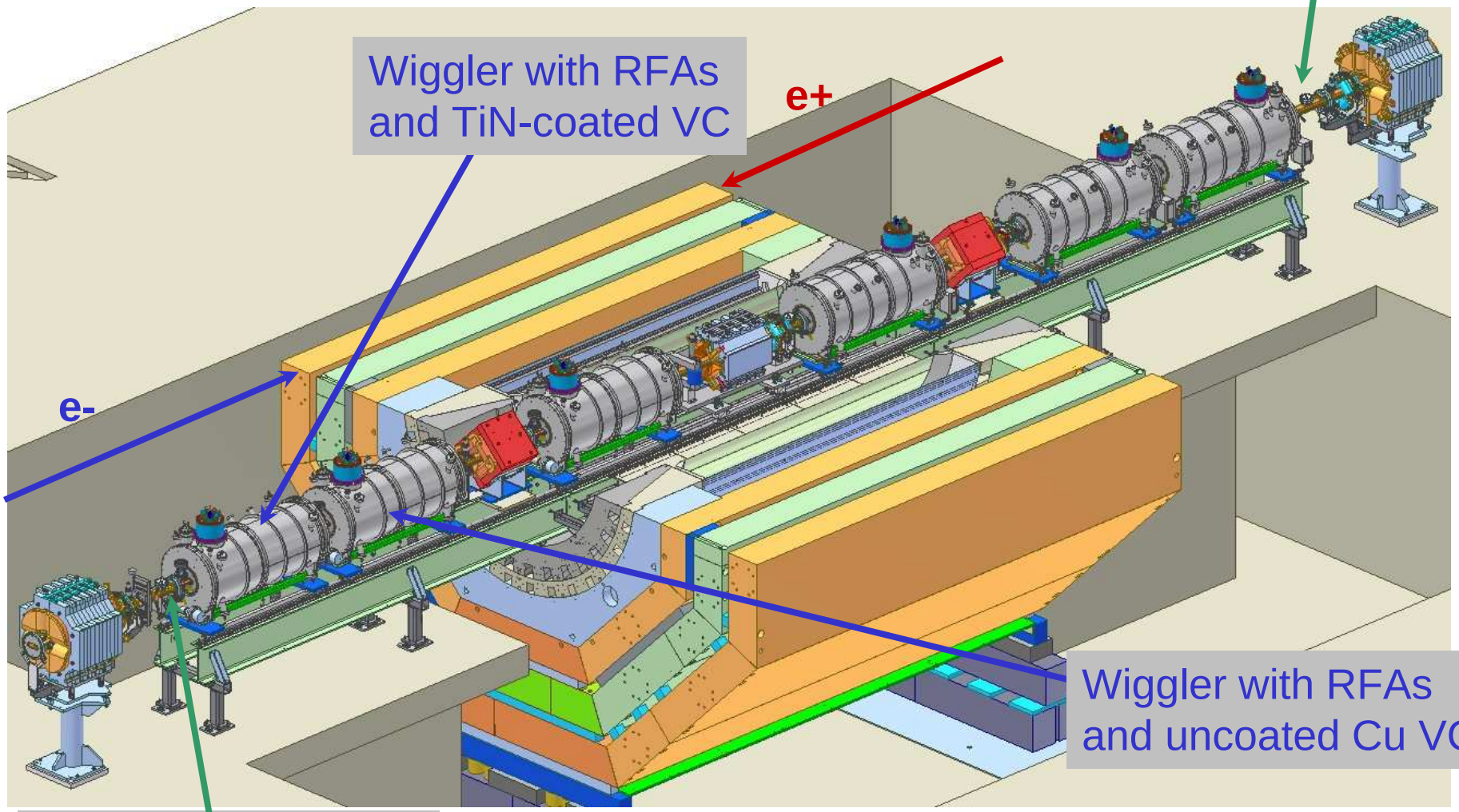
Horizontal



Vertical

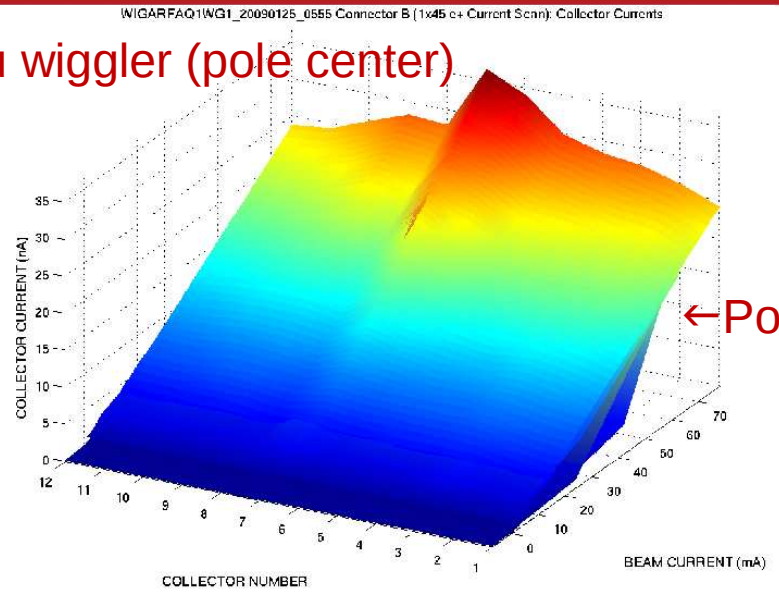


L0 RFA Data


2E Segmented RFA
Wiggler with RFAs
and TiN-coated VC
e+
e-
Wiggler with RFAs
and uncoated Cu VC
2W Segmented RFA

Electron-Positron Comparisons (1x45 Current Scans)

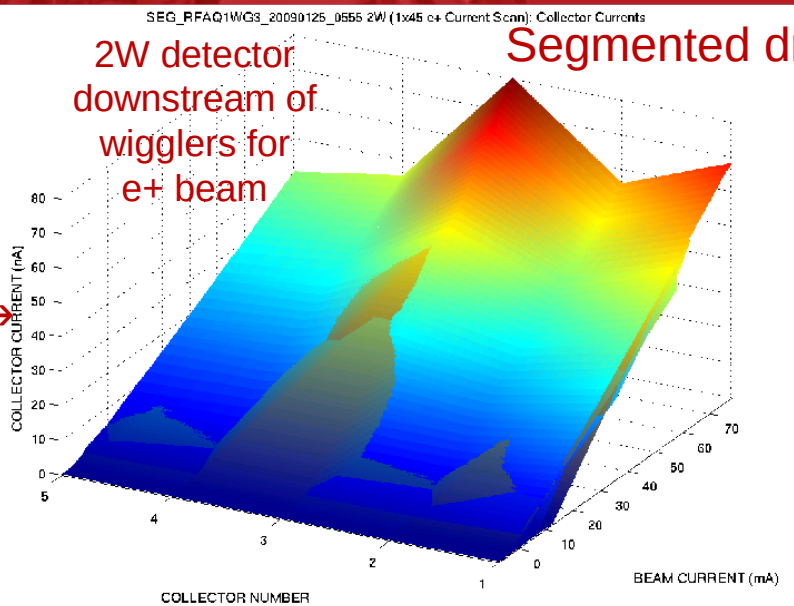
Cu wiggler (pole center)



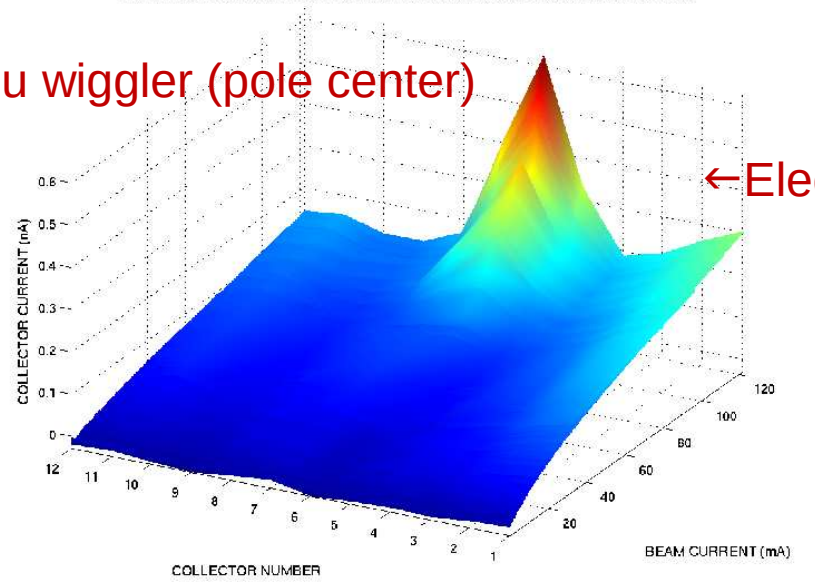
←Positrons→

2W detector downstream of wigglers for e+ beam

Segmented drift



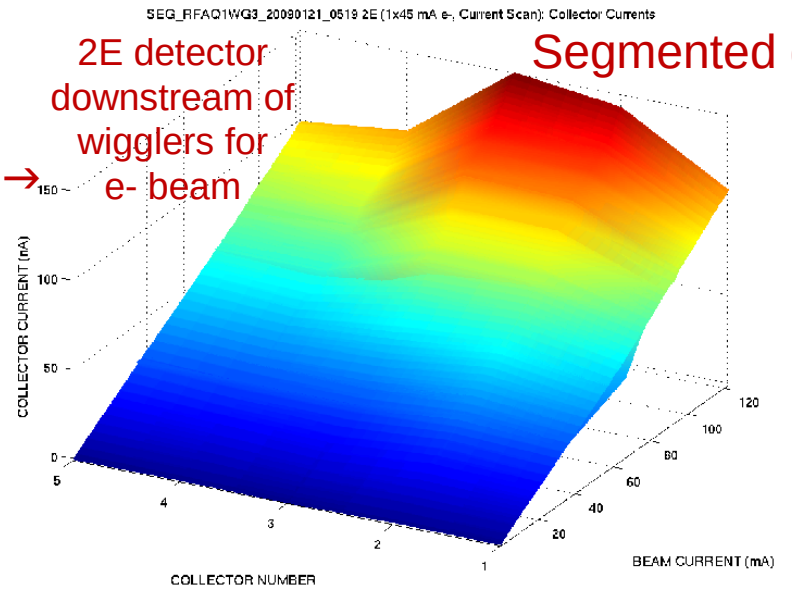
Cu wiggler (pole center)



←Electrons→

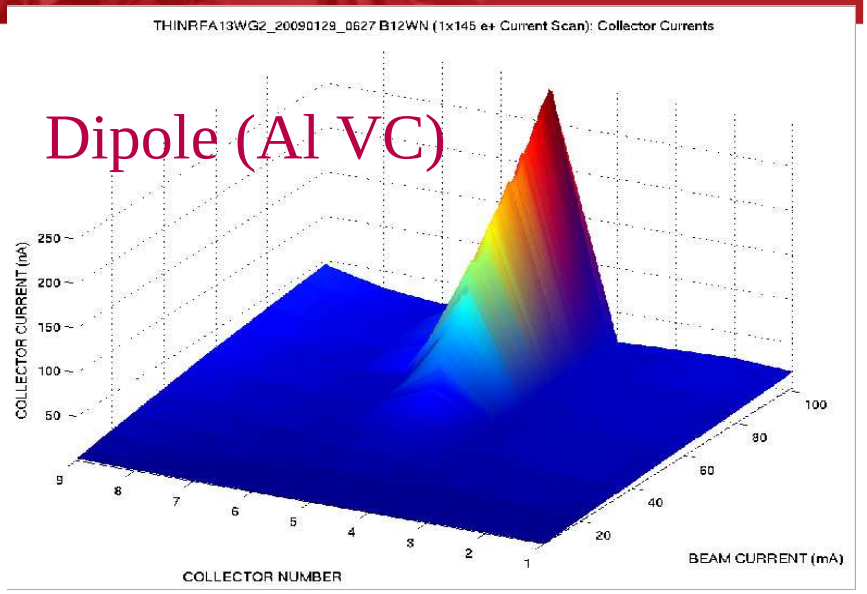
2E detector downstream of wigglers for e- beam

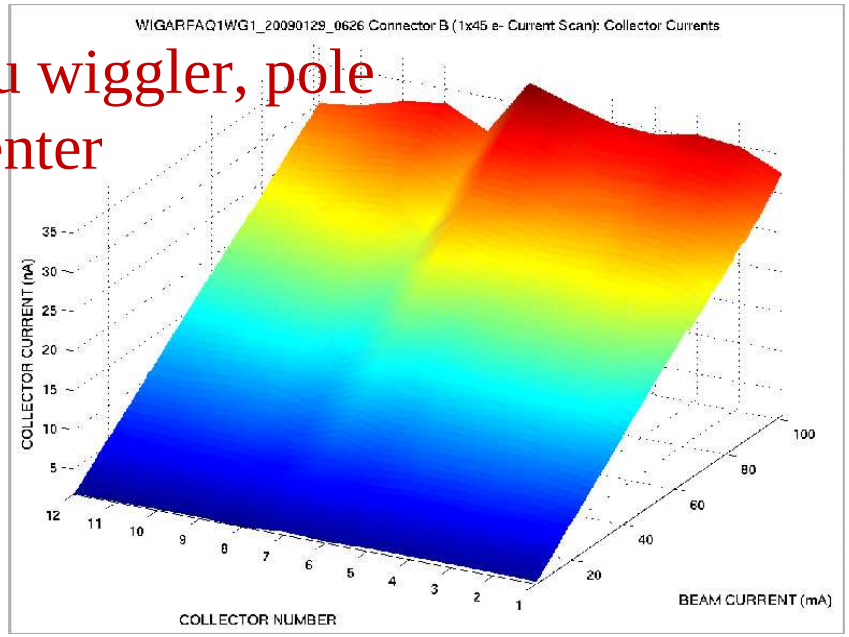
Segmented drift

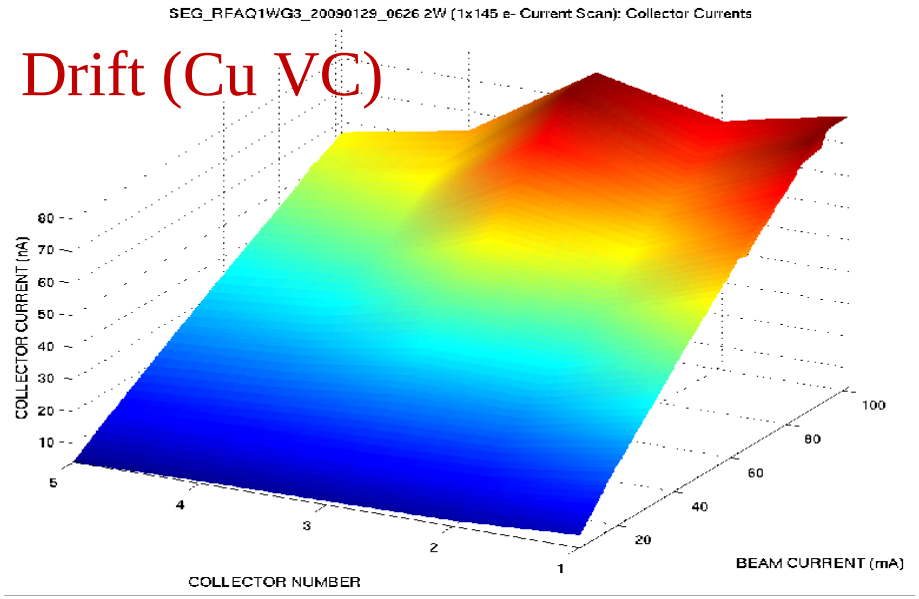


Long Train Data

- 1x**145** e+
  - 14 ns spacing ⇨ 79% of ring filled
  - Multipacting stripe
    - Strongly visible in dipole
    - Weaker in L0 wiggler and drift regions

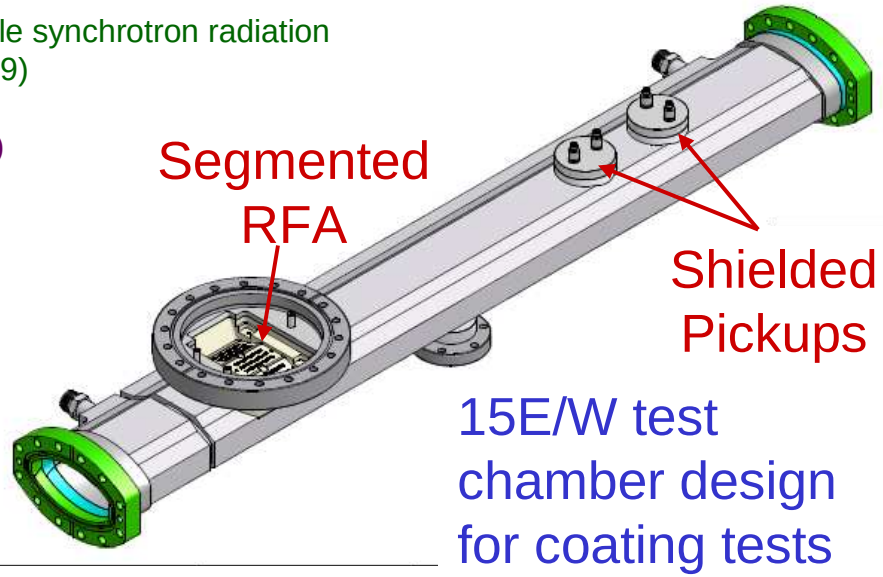






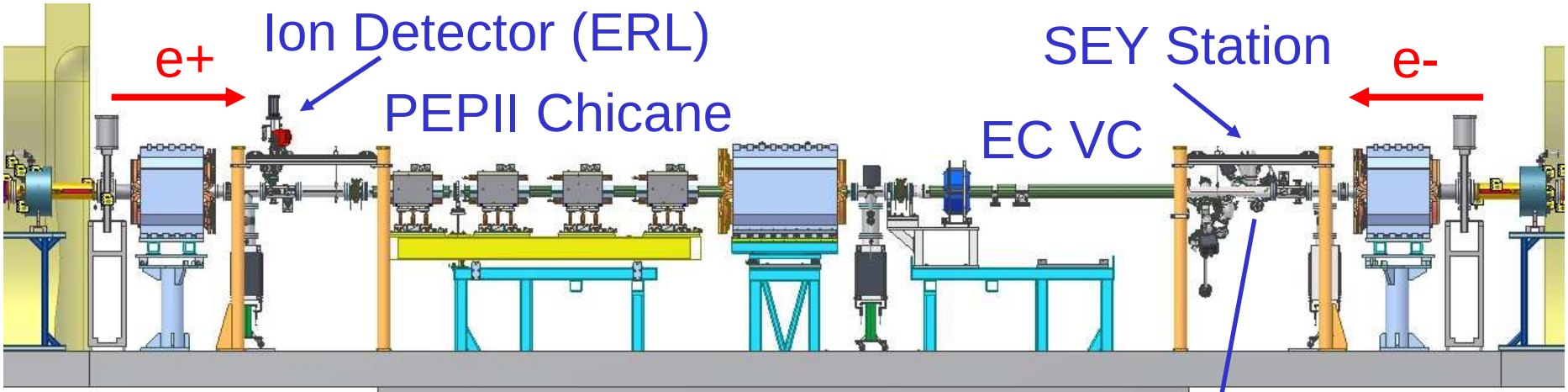
Machine Status and Plans

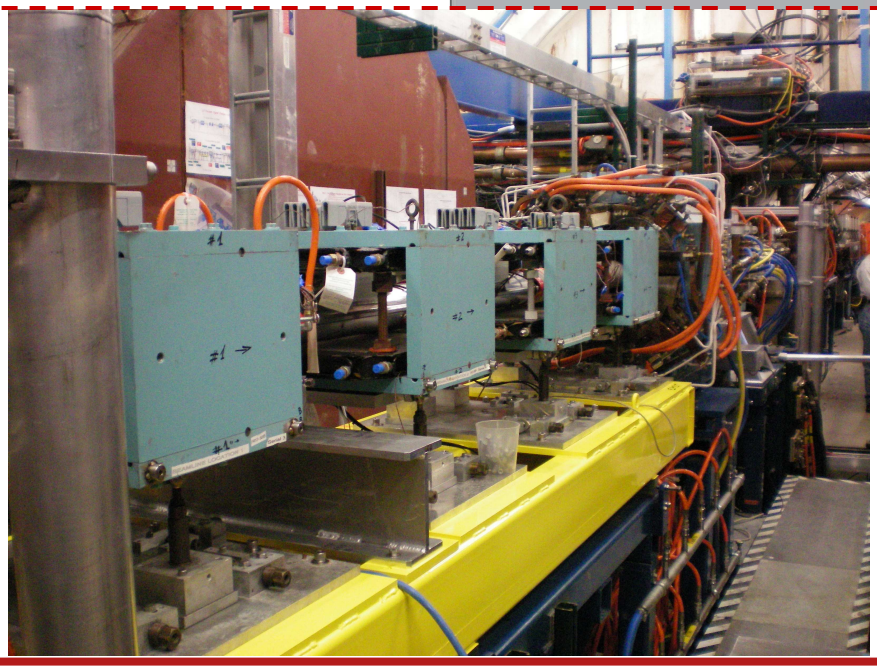
- All major CESR layout modifications are now complete!
  - 4 Experimental areas for EC build-up and mitigation studies
    - L0 wiggler straight
      - Configured for RFA and TE Wave measurements of EC build-up
      - 4 wiggler comparisons planned (CU-KEK-LBNL-SLAC collab.)
        - » Cu vacuum chamber (installed)
        - » TiN coated vacuum chamber (installed)
        - » Grooved vacuum chamber (⇨ summer '09 installation)
        - » Clearing electrode vacuum chamber (⇨ fall '09 installation)
    - L3 straight w/PEP-II chicane and SEY sample station
      - Sample station tests (CU-FNAL-SLAC collab.)
      - Grooved chamber tests (CU-SLAC collab.)
    - 15E/W
      - Flexible location for testing chambers with dipole synchrotron radiation
      - Presently planned comparisons (summer/fall '09)
        - » Al vacuum chamber
        - » α carbon coated VC (CERN-CU collab.)
        - » Enamel chamber with electrode (Project X collab.)
        - » TiN-coated Al vacuum chamber
  - Detailed beam dynamics studies at ultra low emittance
    - Mid-2009 ⇨ end of program
    - Characterize instability thresholds
    - High resolution bunch-by-bunch beam size measurements to characterize incoherent emittance growth
    - Witness bunch studies for flexible control of EC interaction with beam



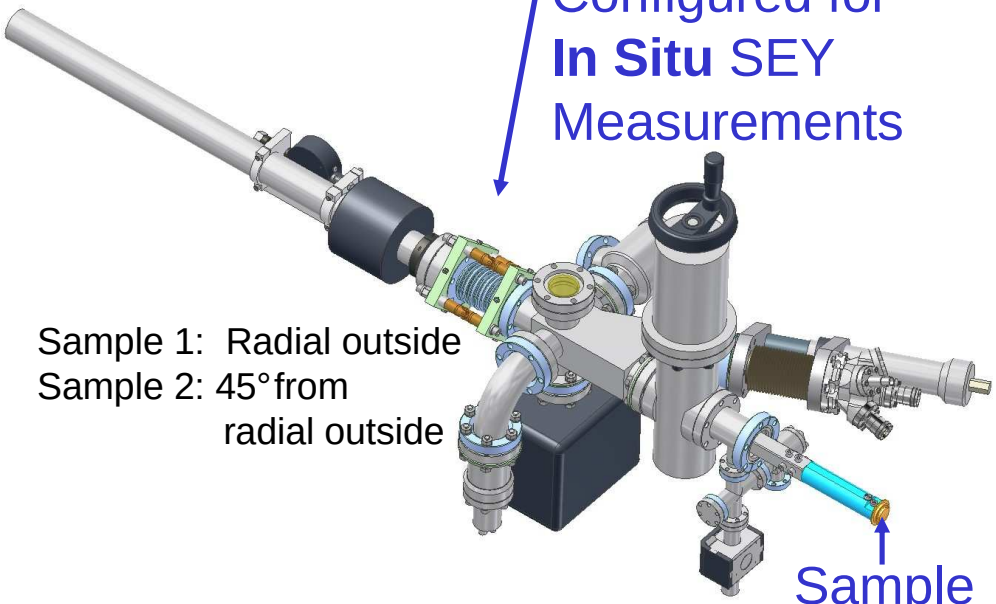
15E/W test chamber design for coating tests

L3 Experimental Region





Configured for **In Situ** SEY Measurements



CesrTA Information

- Next WebEx Meeting: Tuesday, March 10, 9am US EDT - details at: https://wiki.lepp.cornell.edu/ilc/bin/view/Public/CesrTA/CollabMeetings
- Schedule
  - Details at: https://wiki.lepp.cornell.edu/ilc/bin/view/Public/CesrTA/CesrTASchedule
  - Startup period until March 16
  - Some CesrTA machine studies - focused on:
    - 4ns instrumentation and feedback
    - 5 GeV optics
  - Parasitic Machine Studies throughout CHES run will be used to bring newly installed hardware on-line in preparation for spring-summer running periods
- Next Experimental Runs and Downs
  - May 12 – June 16, 2009 Experimental Run
  - June 16 – July 22, 2009 Down (**NOTE:** down has been extended to allow contingency for possible gun structure replacement)
  - Startup and CesrTA Experimental Period through September 7
- 2009 CesrTA Workshop
  - June 25-26 at Cornell
  - Please mark your calendars!